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09/635,116	08/09/2000	Sujian Huang	05516/056002	8958

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ROSENTHAL & OSHA L.L.P.
1221 MCKINNEY AVENUE
SUITE 2800
HOUSTON, TX 77010

EXAMINER	
FERRIS III, FRED O	

ART UNIT	PAPER NUMBER
2128	19

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	09/635,116	HUANG ET AL.	
	Examiner	Art Unit	
	Fred Ferris	2128	

-- The MAILING DATE of this communication appears on the cov r sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *02 January 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disp sition of Claims

4)☒ Claim(s) *1-21 and 23-28* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-21 and 23-28* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

13)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

a) ☐ The translation of the foreign language provisional application has been received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

1. Prosecution on the merits of this application is reopened on claims 1-21, 23-28 considered unpatentable for the reasons indicated below:

- The indicated allowability of claims 1-21, 23-28 is withdrawn in view of the following reference(s) to: U.S. Patent No. 6,527,068; U.S. Patent 6,213,225 issued to Chen; "The Operational Mechanics of The Rock Bit", Ma et al, Petroleum Industry Press, Copyright 1996; "The Computer Simulation of the Interaction Between Roller Bit and Rock", Ma et al.; and Patent 6,095,262 issued to Chen. Rejections based on the newly cited reference(s) follow.

- *The 112 Rejections, subsequently recited.*
- *Objections to the specification, subsequently presented.*

Claim Rejections - 35 USC § 112

The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claims 1-21 and 23-28 are rejected under 35 U.S.C. 112, first paragraph, as based on a disclosure which is not enabling. Matter critical or essential to the practice of the invention, but not included in the claim(s) is not enabled by the disclosure. *See In re Mayhew, 527 F.2d 1229, 188 USPQ 356 (CCPA 1976).*

Specifically, independent claims include limitations relating to "simulating drilling of an earth formation" that have not been sufficiently disclosed in the specification.

While the specification makes reference to "drilling simulation" and mentions certain drill simulation variables such as vertical force, axial distance, displacement, and lateral force that would act on a simulated drill bit, the specification does not disclose specifically how the related calculations are performed. For example, page 11, line 23 recites that "the cone rotation speed is calculated based on the forces on the cutting elements", but does not disclose what the forces are or how they are calculated. Page 8, line 15, as another example, recites "drilling simulation is incrementally calculated by "rotating" the bit through an incremental angle, and then iteratively determining the vertical displacement", but no formulas are given for actually incrementally calculating the drilling simulation or determining the vertical displacement. In general, no algorithms or formulas are given for actually calculating any of the forces acting on the simulated bit or the interface with the earth formation including optimization and balancing roller cone design. Figures 10A-11B and the related passages on pages 21-27 of the specification do not cure this deficiency. Accordingly, one skilled in the art would not know how to make and or use the invention without undue experimentation because critical matter that is essential to the practice of the invention, for supporting the limitations of the claims, is not disclosed in the specification.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. ***Claims 25 and 26 are also rejected under 35 U.S.C. 112(2).*** *The term "substantially balanced" in claims 25 and 26 is a relative term which renders the claim*

indefinite. The term "substantially balanced" is not defined by the claim, the specification does not provide a standard for ascertaining the requisite degree, and one of ordinary skill in the art would not be reasonably apprised of the scope of the invention.

Specification

4. The apparent attempt to incorporate subject matter into this application by reference to "The Computer Simulation of the Interaction Between Roller Bit and Rock", D. Ma et al, paper no. 29922, Society of Petroleum Engineers, 1995, is improper because it contains matter that is critical to the operation of the claimed invention for supporting the limitations of the claims. For example, page 310, column 2 of this reference discloses the formula for modeling an arbitrary point (M) on a rotating based on the rotation angle of the cone and structure parameters of the bit, while page 312, column 2 discloses the model of the interfacing force between tooth an rock. This reference supplies some of the missing essential features including:

- *specifically how the related calculations are performed.*
- *what the forces are and how they are calculated.*
- *formulas are for actually incrementally calculating the drilling simulation and determining the vertical displacement.*
- *algorithms and formulas for actually calculating forces acting on the simulated bit and the interface with the earth formation*
- *optimization and balancing roller cone design.*

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970);and, *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

5. Claims 1, 5, and 23, 24, 27, and 28 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-9 of U.S. Patent No. 6,527,068.

Although the conflicting claims are not identical, they are not patentably distinct from each other because claims 1-9 of U.S. 6,527,068 are drawn to limitations that are functionally equivalent to the limitations of claims 1, 5, and 23, 24, 27 and 28 of the present invention. These include:

- *Optimizing a roller cone drill bit*
- *Simulating drilling an earth formation*
- *Determining performance parameters*
- *Adjusting orientation of elements (axial forces, geometric parameters)*
- *Repeating simulation of drilling to optimize design parameters*
- *Adjusting performance parameters to obtain optimum design*
- *Simulating roller cone cutting elements and rate of penetration*

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

6. Claims 1-21 and 23-28 are rejected under 35 U.S.C. 102(e) as being clearly anticipated by U.S. Patent 6,213,225 issued to Chen (of record).

Claims 1, and 5 include limitations drawn to:

A method for **determining axial force**, **volume of formation cut**, for a roller cone drill bit by:

Simulating roller cone earth drilling by calculating:
Geometry (selecting parameters) of roller cutting elements
Characteristic (selecting) of earth formation (simulated) being drilled
Axial force on cutting elements
Simulating incrementally (selective) rotating bit and recalculating forces on cutting elements based on design parameters
Repeating the simulation for selected rotations
Combining axial force on cutting element rollers to determine each axial force
Combining carter volume for each cutting element to determine volume cut by roller

Regarding independent claims 1 and 5: Chen discloses simulating roller cone earth drilling by calculating roller cone element geometry (CL7-L36, CL7-L56 to CL8-L21), selecting parameters (CL5-L67, CL9-59), and simulated earth formation characteristics (CL10-L14, CL6-L57-CL7-9, CL9-L43). Chen further discloses

calculating the axial force on cutting elements (Abstract, CL5-L36, CL7-L56 to CL8-L21, CL10-L45, CL1-L11-21), simulating an incrementally rotating bit (CL11-L34-39, CL10-L47-63, CL8-L41-53, CL7-L52), and recalculating cutting element forces based on design parameter (CL8-L37-CL9-L57, CL10-L2, CL11-L7, Fig. 6). Chen also discloses repeating the simulation (CL10-L2, CL11-L7) and determining each axial force by combining axial forces on cutting elements (CL11-L11-21), and combining crater volumes for each cutting element to determine each rollers contribution (CL11-35). (Also see: Abstract, Background, CL6-L 57, CL7-L56, CL8-L28, Figs. 1-9)

Regarding dependent claims 2-4 and 6-9: Dependent claims 2-4 and 6-9 include limitations drawn to simulating axial drill forces on cutting elements when drilling a simulated formation and are therefor rejected using the same reasoning as cited above. Claims 4, and 8 include limitations relating to the use of experimental earth formation (also taught by Chen: CL5-L9, CL7-L37). Chen also discloses simulating the depth of penetration (CL14-L2, CL2-L20).

Claims 10, and 16 include limitations drawn to:

A method for **balancing axial forces**, and **balancing volume cut**, for a roller cone drill bit by:

Simulating roller cone earth drilling by calculating geometry of roller cutting elements based on characteristic of earth formation being drilled
    Axial force on cutting elements
Simulating incrementally rotating bit and recalculating forces on cutting elements
Repeating the simulation for selected incremental rotations
Combining axial force on cutting element of each roller cone
Adjusting design parameter and repeating simulation until difference between each combined axial force less than value prior to repeating/adjusting

Regarding independent claims 10 and 16: Chen discloses balancing the axial forces on a roller cone drill bit (CL4-45 to CL5-65, CL7-L56 to CL8-L21), and balancing the volume of formation (rock) cut (CL5-39, CL6-L60-CL9-45, Especially CL9-L20) by

each simulated roller cone (CL11-L8, CL9-L20). Chen further discloses calculating the axial force on cutting elements (Abstract, CL5-L36, CL7-L56 to CL8-L21, CL10-L45, CL1-L11-21), simulating an incrementally rotating bit (CL11-L34-39, CL10-L47-63, CL8-L41-53, CL7-L52), and recalculating cutting element forces based on adjusted design parameters (CL8-L37-CL9-L57, CL10-L2, CL11-L7, Fig. 6). Chen also discloses repeating the simulation and adjusting design parameter (i.e. repeating until "optimized" over the prior simulation: CL10-L2, CL11-L7), and determining each axial force by combining axial forces on cutting elements (CL11-L11-21). (Also see: Abstract, Background, CL6-L 57, CL7-L56, CL8-L28, Figs. 1-9)

Regarding dependent claims 11-15 and 17-21: Dependent claims 11-15 and 17-21 include limitations drawn to simulating axial drill forces (movement) on cutting elements when drilling a simulated formation and are therefor rejected using the same reasoning as cited above. Chen also discloses simulating the depth of penetration (CL14-L2, CL2-L20).

Regarding independent claims 23-26: Independent claims 23-26 are drawn to optimizing roller cone bit design and include the same limitations (although somewhat broader) as previously addressed above. Accordingly, the examiner rejects claims 22-26 using the same reasoning as cited above.

7. Claims 1, 5 and 23, 24, 27, and 28 are also rejected under 35 U.S.C. 102(b) as being clearly anticipated by "The Operational Mechanics of The Rock Bit", Ma et al, Petroleum Industry Press, Copyright 1996. (of record)

Ma et al discloses techniques for optimizing the design of a roller bit (chapter 6) drilling a simulated earth formation (chapter 5), the operational mechanics of roller bit geometry and cutting elements (chapter 2, 6.1), the kinematics of the bit (teeth, rollers, scraping formation, etc. chapter 3), rock and bit iteration (volume, etc. chapter 5), and bit design and force analysis (optimize using computer simulation by size, load, motion, stress, etc. chapter 6, section 5.4, especially page 232, based on the entire teaching).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

8. Claims 1-9, 23, 24, 27 and 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 6,095,262 issued to Chen in view of "The Computer Simulation of th Interaction Between Roller Bit and Rock", Ma t al (both of record).

Claims 1, and 5 include limitations drawn to:

A method for **determining axial force**, **volume of formation cut**, for a roller cone drill bit by:

Simulating roller cone earth drilling by calculating:
Geometry (selecting parameters) of roller cutting elements
Characteristic (selecting) of earth formation (simulated) being drilled
Axial force on cutting elements
Simulating incrementally (selective) rotating bit and recalculating forces on cutting elements based on design parameters
Repeating the simulation for selected rotations
Combining axial force on cutting element rollers to determine each axial force
Combining carter volume for each cutting element to determine volume cut by roller

Regarding independent claims 1 and 5: Chen 262' discloses simulating roller cone earth drilling and determining the axial forces on cutting elements (CL-L63 to CL8-L27, CL7-L4, CL7-L26) and volume cut (CL7-L38) for a roller cone bit by calculating roller cutting element geometry (CL7-L4 to CL9-L28) and selecting design parameters (CL7-L5, 61, CL8-7, CL10-19). Chen 262' further discloses simulating a rotating bit and recalculating forces on cutting elements (repeating simulation) to optimize design (CL7-L7-45, CL13-23-29). (Also see bit rotation, time step intervals CL7-L17, CL7-L30, Abstract, Background, CL10-L19 to CL11-L35, CL12-L18 to CL14-L33, Figs. 1A- 8B)

Chen 262' mentions, but does not explicitly teach a model for various types of earth formations and does not explicitly teach combining the crater volumes.

Ma (Simulation) also teaches simulating roller cone earth drilling, determining axial forces on cutting elements (page 310 - 313), and calculating roller cutting element geometry (pages 310-313), but further discloses an earth formation crater model (page 312) for various types of rock formation and the combining of crater volumes for each roller cutting element (page 312, 313).

It would have been obvious to one having ordinary skill in the art at the time the claimed invention was made to modify the teachings of Chen 262' relating to simulating roller cone earth drilling and recalculating forces on cutting elements to optimize the bit design, with the teachings of Ma (Simulation) relating to an earth formation crater model and the combining of crater volumes, to realize the claimed invention. An obvious motivation exists since this area of technology is highly competitive with numerous optimization products available in the market place and large amounts of money being spent in product development and improvement. (see Ma page 17, for example) Accordingly, a skilled artisan would have made an effort to become aware of what capabilities had already been developed in the market place and, hence, would have been motivated to modify the teachings of Chen 262' with the teachings of Ma (Simulation) in order to reduce development time and cost.

Regarding dependent claims 2-4 and 6-9: Dependent claims 2-4 and 6-9 include limitations drawn to simulating axial drill forces on cutting elements when drilling a simulated formation and are therefor rejected using the same reasoning as cited above. Chen 262' also discloses simulating roller cone bit drilling penetration (CL11-67).

Regarding independent claims 23, 24, 27, and 28: Independent claims 23, 24, 27, and 28 are drawn to optimizing roller cone bit design and include the same limitations (although somewhat broader) as previously addressed above. Accordingly, the examiner rejects claims 23, 24, 27, and 28 using the same reasoning as cited above.

9. Claims 11-21, 25, and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 6,095,262 issued to Chen in view of "The Computer Simulation of the Interaction Between Roller Bit and Rock", Ma et al, in further view of U.S. Patent 6,213,225 issued to Chen.

Claims 10, and 16 include limitations drawn to:

A method for **balancing axial forces**, and **balancing volume cut**, for a roller cone drill bit by:

Simulating roller cone earth drilling by calculating geometry of roller cutting elements based on characteristic of earth formation being drilled
Axial force on cutting elements
Simulating incrementally rotating bit and recalculating forces on cutting elements
Repeating the simulation for selected incremental rotations
Combining axial force on cutting element of each roller cone
Adjusting design parameter and repeating simulation until difference between each combined axial force less than value prior to repeating/adjusting

Regarding independent claims 10 and 16: As previously cited above, Regarding independent claims 1 and 5: Chen 262' discloses simulating roller cone earth drilling and determining the axial forces on cutting elements (CL-L63 to CL8-L27, CL7-L4, CL7-L26) and volume cut (CL7-L38) for a roller cone bit by calculating roller cutting element geometry (CL7-L4 to CL9-L28) and selecting design parameters (CL7-L5, 61, CL8-7, CL10-19). Chen 262' further discloses simulating a rotating bit and recalculating forces on cutting elements (repeating simulation) to optimize design (CL7-L7-45, CL13-23-29). (Also see bit rotation, time step intervals CL7-L17, CL7-L30, Abstract, Background, CL10-L19 to CL11-L35, CL12-L18 to CL14-L33, Figs. 1A- 8B)

Chen 262' mentions, but does not explicitly teach a model for various types of earth formations and does explicitly not teach combining the crater volumes.

Ma (Simulation) also teaches simulating roller cone earth drilling, determining axial forces on cutting elements (page 310 - 313), and calculating roller cutting element geometry (pages 310-313), but further discloses an earth formation crater model (page 312) for various types of rock formation and the combining of crater volumes for each roller cutting element (page 312, 313).

Chen 262' further does not explicitly teach balancing axial forces and volume cut.

Chen 225' teaches balancing the axial forces on a roller cone drill bit (CL4-45 to CL5-65, CL7-L56 to CL8-L21), and balancing the volume of formation (rock) cut (CL5-39, CL6-L60-CL9-45, Especially CL9-L20) by each simulated roller cone (CL11-L8, CL9-L20).

It would have been obvious to one having ordinary skill in the art at the time the claimed invention was made to modify the teachings of Chen 262' relating to simulating roller cone earth drilling and recalculating forces on cutting elements to optimize the bit design, with the teachings of Ma (Simulation) relating to an earth formation crater model and the combining of crater volumes, to realize the claimed invention. An obvious motivation exists since this area of technology is highly competitive with numerous optimization products available in the market place and large amounts of money being spent in product development and improvement. (see Ma page 17, for example) Accordingly, a skilled artisan would have made an effort to become aware of what capabilities had already been developed in the market place and, hence, would have been motivated to modify the teachings of Chen 262' with the teachings of Ma

(Simulation), and to further modify the teachings of Chen 262' with the teachings of Chen 225' (balancing), in order to reduce development time and cost.

Regarding dependent claims 11-15 and 17-21: Dependent claims 11-15 and 17-21 include limitations drawn to simulating axial drill forces (movement) on cutting elements when drilling a simulated formation and are therefor rejected using the same reasoning as cited above. Chen also discloses simulating the depth of penetration (CL14-L2, CL2-L20).

Regarding independent claims 25 and 26: Independent claims 25 and 26 are drawn to optimizing roller cone bit design and include the same limitations (although somewhat broader) as previously addressed above. Accordingly, the examiner rejects claims 22-26 using the same reasoning as cited above.

While the specification for the claimed invention is delinquent in the areas cited under 112(1) and 112(2) rejections, the examiner has made prior art rejections based on the limited scope of information contained in the specification and the language of the claims.

Conclusion

10. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

"Experimental and Theoretical Analysis of Roller Cone Bit Vibrations", S. Naganawa, Energy & Environmental Expo 95 Drilling Symposium, 1995 teaches roller bit element geometry.

U.S. Patent 6,021,377 issued to Dubinsky et al teaches drilling simulation.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Fred Ferris whose telephone number is 703-305-9670 and whose normal working hours are 8:30am to 5:00pm Monday to Friday.

Any inquiry of a general nature relating to the status of this application should be directed to the group receptionist whose telephone number is 703-305-3900.

The Official Fax Numbers are:

Official (703) 872-9306

Fred Ferris, Patent Examiner
Simulation and Emulation, Art Unit 2123
U.S. Patent and Trademark Office
Crystal Park 2, Room 5D53
Crystal City, Virginia 22202
Phone: (703) 305 - 9670
FAX: (703) 305 - 7240
Fred.Ferris@uspto.gov
January 8, 2004

KEVIN J. TESKA
SUPERVISORY
PATENT EXAMINER